Experiment: Differential Amplifier

Aim:

To implement a differential amplifier of gain 10 and analyze its transient characteristics.

Tool Used:

LTspice

Theory:

Differential amplifiers apply gain not to one input signal but to the difference between two input signals. This means that a differential amplifier naturally eliminates noise or interference that is present in both input signals.

For a Level 3 NMOS, PMOS let's assume

$V_T = 0.4V$

$V_{DD} = 1.8V$

$K_n = 120\mu A/V^2$,

$K_p = 120\mu A/V^2$,

Which implies

$r_{01} = 1/\ \text{lambda}_n * I_D$

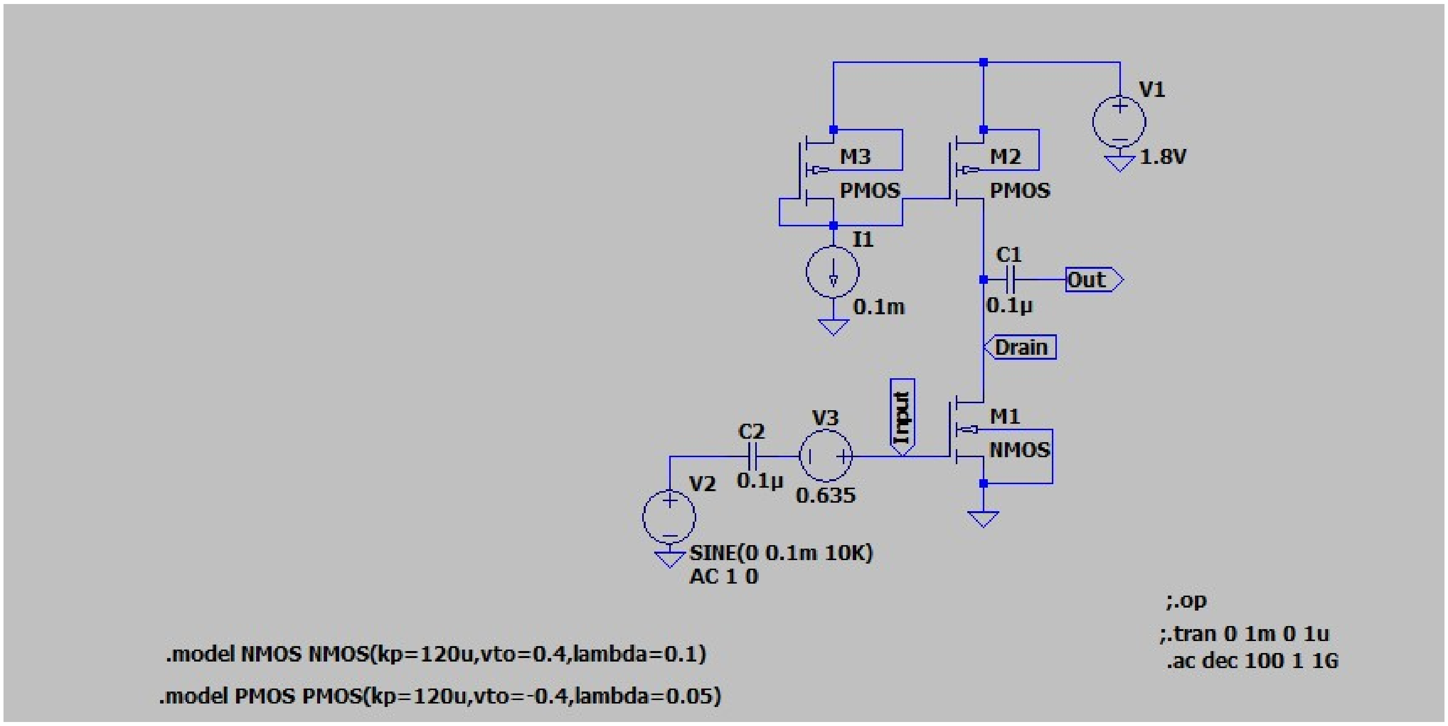
$r_{02} = 1/\ \text{lambda}_p * I_D$

Which gives the value of R_{out} to be 16.66Kohm

Which gives a value of (W/L) = 30 for 100uA I_D.

Hence with this value of W/L we get a V_{GS} of 0.635V

Circuit Schematic:

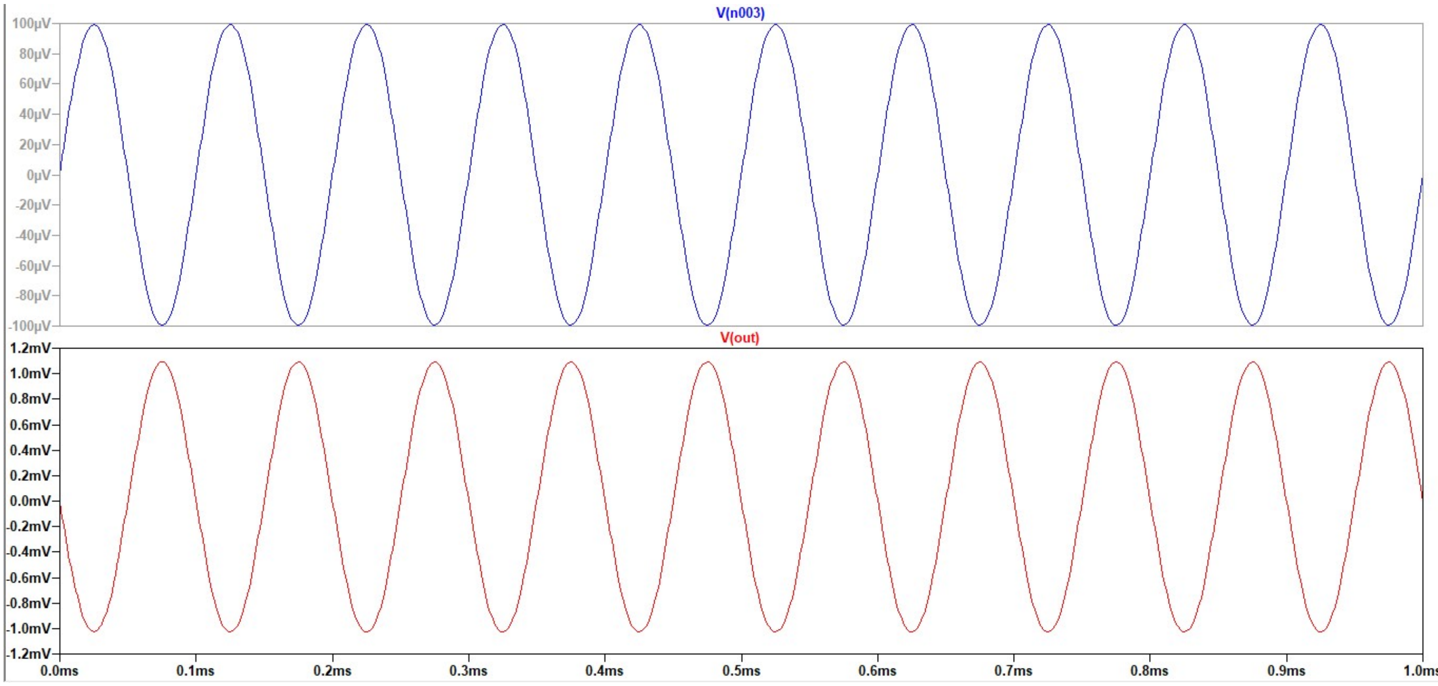


Output Waveforms:

```
        --- Operating Point ---

V(n001):         1.8             voltage
V(n002):         0.15892         voltage
V(drain):        0.218448        voltage
V(out):          2.18448e-008    voltage
V(input):        0.635           voltage
V(n003):         0               voltage
V(n004):         0               voltage
Id(M1):          9.97249e-005    device_current
Ig(M1):          0               device_current
Ib(M1):          -2.28446e-013   device_current
Is(M1):          -9.97249e-005   device_current
Id(M3):          0.0001          device_current
Ig(M3):          -0              device_current
Ib(M3):          1.65108e-012    device_current
Is(M3):          -0.0001         device_current
Id(M2):          9.97249e-005    device_current
Ig(M2):          -0              device_current
Ib(M2):          1.59155e-012    device_current
Is(M2):          -9.97249e-005   device_current
I(C2):           0               device_current
I(C1):           -2.18448e-020   device_current
I(I1):           0.0001          device_current
I(V3):           0               device_current
I(V2):           0               device_current
I(V1):           -0.000199725    device_current
```

Transient characteristics



Result:

The circuit is designed for a gain of 10 and the output is verified to be correct.